NOTE: The attached PDF document is based on an original May 2, 2001, NMFS memorandum entitled "*Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2001*."

This document contains revised smolt outmigration estimates and supersedes a previous version dated March 22, 2001.

While the information herein is a facsimile of that contained in the original memorandum, actual pagination differs slightly due to the PDF conversion.

Northwest Fisheries Science Center
Fish Ecology Division
2725 Montlake Boulevard East
Seattle, Washington 98112-2097

May 2, 2001

MEMORANDUM FOR:F/PR - Donald R. Knowles

FROM: F/NWC3 - Michael H. Schiewe

SUBJECT: Estimation of Percentages for Listed Pacific Salmon and Steelhead Smolts Arriving at Various Locations in the Columbia River Basin in 2001

Each year your office requests a description of how the Fish Ecology Division calculates the percentages of listed wild and hatchery fish at selected Columbia and Snake River projects. These estimates are necessary for evaluating the potential impacts of proposed research on listed species. Given new hatchery release estimates, we have computed percentages for 2001. The attached tables show our best estimates for the total numbers of protected juvenile Pacific salmon and steelhead arriving at Columbia River and Snake River dams during the 2001 outmigration, and the percentage of the total collection they will comprise at each dam. Because of the low flows expected this year, and after consulting with the Northwest Region Hydro Program and the Protected Resources Division regarding river operations in 2001 (Pers. commun., February 2001), we have developed estimates based on a “spread the risk” scenario (transportation with spill; assuming river conditions that have existed in the past) and on a full transportation scenario (with no spill). Tables 1-6 show the development of the estimates, and Tables 7-10 summarize the estimates for each listed species at each project. We are providing this information so that Protected Resources Division (F/PR3) staff can better understand how these percentages were derived. Although the following descriptions may seem intimidating, it was necessary to provide this level of detail to describe anticipated conditions for 2001.

Several Snake River species will have unmarked hatchery fish released for the 2001 outmigration. Approximately 620,000 hatchery spring/summer chinook salmon will be released with only a coded-wire tag (CWT) (no external mark). Because we have encountered unmarked hatchery spring/summer chinook salmon in the past, we have adopted a practice of labeling any unclipped spring/summer chinook salmon that is greater than 124-mm in fork length as hatchery-origin fish. To derive this fork length, we analyzed data from wild spring/summer chinook salmon PIT-tagged

in their natal streams (by our wild parr marking project; Permit #1056, Study 1) that were subsequently captured and re-measured at one of the lower Snake River dams during slide-gate evaluations (1989 to 1994).

Approximately 1,000,000 hatchery steelhead will also be released in 2001 with no external mark. Of these fish, 100,000 will have a CWT. Juvenile hatchery steelhead are usually identifiable by their degraded fins, particularly the dorsal and pectoral fins.

Approximately 1,500,000 unlisted Lyons Ferry Hatchery subyearling fall chinook salmon may be released above Lower Granite Dam. Of these fish, 1,200,000 will be unmarked, making them indistinguishable from wild subyearling fish. The effects of these fish are covered in the section on subyearling fall chinook salmon.

All researchers should be aware that 355,400 yearling fall chinook salmon will be released above Lower Granite Dam in 2001, and that 454,000 yearling fall chinook salmon will be released directly from Lyons Ferry Hatchery. All of the Lyons Ferry Hatchery yearling releases will be marked with visual eye tags. Since these hatchery fish are not currently listed, all researchers should be certain that they identify these fish as fall chinook salmon, not as listed yearling spring/summer chinook salmon.

For several groups of fish, we could find no new information; therefore, our estimates for these groups are the same as last year.

Feel free to discuss this memorandum with all interested parties.

Attachments

cc: F/NWC1 - Waples
F/NWC2 - Iwamoto
F/NWC3 - Casillas
F/NWC3 - Dey
F/NWC3 - Ferguson
F/NWC3 - Gores
F/NWC3 - Ruehle
F/NWC3 - Williams
F/NWC4 - Clarke
F/NWC5 - Stein
F/NWR3 - Griffin
F/NWR3 - Koch
F/PR3 - Mobley
F/PR3 - Cain

SPRING/SUMMER CHINOOK SALMON ESTIMATES

Snake River ESU

Our estimate of wild fish arriving at Lower Granite Dam is based on Idaho Department of Fish and Game's smolt yield estimates for Snake River stocks (Russ Keifer, IDFG, Pers. commun., February 2001). According to their estimates, 478,200 wild/natural spring/summer chinook salmon will reach Lower Granite Dam in 2001. We estimate that 4,080,458 hatchery smolts will be released from Idaho (3,680,958) and Oregon (399,500).

In order to estimate how many hatchery smolts will reach Lower Granite Dam, we first estimated the percentage composition of Snake River spring/summer chinook salmon arriving at the dam from listed hatcheries (Table 1). Using the mean survival estimates for the 1993-2000 outmigrations, we estimated the total number of hatchery fish that will arrive at Lower Granite Dam. We applied the mean survival estimate for each hatchery from these 8 years to the 2001 projected release numbers for each hatchery. We estimate that 2,422,826 or 59.4% of the 4,080,458 hatchery fish released will arrive at Lower Granite Dam.

The percentage composition of listed hatchery spring/summer chinook salmon arriving at Lower Granite Dam in 2001 will be 21.2024% (Table 1). Using this percentage, we estimated the number of listed hatchery fish arriving at Lower Granite Dam.

$$\begin{pmatrix}\text{listed hatchery}\\ \text{fish to Granite}\end{pmatrix} = \begin{pmatrix}\text{total hatchery fish}\\ \text{arriving at Granite}\end{pmatrix} \times \begin{pmatrix}\text{\% of listed}\\ \text{hatchery fish}\end{pmatrix} =$$

$$513{,}697 = 2{,}422{,}826 \times 0.212024$$

Knowing the total number of hatchery fish, the number of listed hatchery fish, and the number of wild fish arriving at Lower Granite Dam, we estimated the percentage composition of listed hatchery fish and wild fish arriving at the dam.

$$\text{total smolts} = \text{total hatchery fish} + \text{wild fish} = 2{,}901{,}026 = 2{,}422{,}826 + 478{,}200$$

$$\%\ \text{wild fish to dam} = \text{wild fish/total smolts} = 16.5\% = 478{,}200/2{,}901{,}026$$

$$\%\ \text{listed hatchery fish} = \text{listed hatchery fish/total smolts} = 17.707\% = 513{,}697/2{,}901{,}026$$

We set fish guidance efficiencies (FGE) at Lower Granite and Little Goose Dams to 42.6% and 44.3%, respectively. Using an FGE of 42.6%, the total collection at Lower Granite Dam will be 1,235,837 (2,901,026 x 0.426), based on 2,901,026 smolts arriving at the dam. Wild, listed hatchery, and non-listed hatchery fish, will comprise 203,913, 218,830, and 813,094 of the total collection, respectively.

Tucannon River fish, both hatchery and wild, are within the Snake River spring/summer chinook salmon Evolutionarily Significant Unit (ESU) and are considered listed fish. In spring 2001, 16,000 wild fish and 100,000 hatchery fish are expected to outmigrate from the Tucannon River. The Tucannon River joins the Snake River between Little Goose and Lower Monumental Dams. Because of the short distance from the confluence to Lower Monumental Dam, we assumed no mortality of these fish prior to Lower Monumental Dam. The estimates shown in Table 2 and Tables 7-8 reflect the addition of these fish above Lower Monumental Dam.

Over the past four years, all PIT-tagged fish bypassed at the collection dams (Lower Granite, Little Goose, Lower Monumental, and McNary Dams) have been returned to the river to continue migrating inriver. This return of fish to the river requires adjustment of our estimates of the number of listed fish that reach McNary Dam. We estimated the number of fish that will be PIT-tagged for 2001 and assumed that 25% of the Comparative Survival Study (CSS) fish (Larry Basham, FPC, Pers. Comm., February 2001) and 100% of the rest of the fish would be returned to the river at each Snake River collector dam. If transportation occurs at McNary Dam, we also assumed that 100% of all PIT-tagged fish would be returned to the river. A detailed description of how we estimated the impact of returning PIT-tagged fish to the river is presented in Appendix A. We estimated that 17,770 PIT-tagged spring/summer chinook salmon from the Snake River (including 11,398 wild and 1,650 listed hatchery fish) will be collected at McNary Dam because they were returned to the river at an upstream dam(s). These numbers represent collected fish. Dividing the collected number by the FGE at McNary Dam, we determined that 31,058 wild (11,398/0.367) and 4,495 listed hatchery (1,650/0.367) fish will arrive at McNary Dam and must be added to the number of fish that were estimated to reach McNary Dam as a result of not having been collected at an upstream dam (column "Listed fish to McNary", Table 2).

Upper Columbia River ESU

The Upper Columbia River ESU spring chinook salmon is listed as endangered under the ESA. The ESU begins at the confluence of the Yakima and Columbia Rivers and continues upstream to Chief Joseph Dam.

Adults that returned in 1999 produced the smolts that will outmigrate in 2001. We obtained 1999 redd counts for the major Columbia River tributaries in this ESU from Washington Department of Fish and Wildlife (WDFW) and the Yakima Indian Nation. Fecundity estimates for this ESU range from 4,000 to 5,500 eggs per female. Estimates for egg-to-smolt survival generally range up to 19%. Using the median egg count, 4,750, and a conservative egg-to-smolt survival estimate of 15%, we estimated the number of smolts that each stream will produce. Because we have no survival estimates for these streams, we again took a conservative approach and assumed that all smolts would survive to the first dam they encountered.

We also have hatchery release estimates for this ESU from WDFW and the U.S. Fish and Wildlife Service. There are no survival estimates for these hatcheries. So, based on the distance from the hatchery to the first dam the fish will encounter, we assigned the same survival estimates for Snake River hatcheries, with similar distances to the first dam. Using this method, we assigned a survival rate of 0.774 (Dworshak Hatchery's survival estimate to Lower Granite Dam) to the fish from Winthrop, Methow, Entiat, and Leavenworth Hatcheries, a survival estimate of 0.619 (Rapid River Hatchery's estimate to Lower Granite Dam) to Cle Elum Hatchery, and a survival estimate of 100% to Eastbank and Ringold Hatcheries.

Because we have no per-project survival information for spring chinook salmon in the Columbia River above McNary Dam, we assigned the same per-project estimate (0.9) used on the Snake and lower Columbia Rivers. Survival estimates derived from a one year study using yearling hatchery fall chinook salmon support using this estimate (M. Brad Eppard, NMFS, Pers. comm., January 1999).

Based on the assumptions stated above, we derived the estimates shown in Table 7. We estimate that 2,825,300 spring chinook salmon will arrive at McNary Dam. Listed wild, non-listed wild, listed hatchery, and non-listed hatchery fish, will comprise 55,816, 292,125, 212,058, and 2,265,301 of the total number, respectively. Note that the numbers shown for Columbia River dams above McNary Dam are numbers arriving at the dam and not the numbers collected at the dam. The reason for this is that fish

guidance efficiency (FGE) for these dams is either unknown or is currently being evaluated.

Estimate of Fish Arriving at McNary Dam

McNary Dam is the first dam on the Columbia River below the confluence of the Snake River. To obtain an estimate of the number of spring/summer smolts arriving at McNary Dam, we added the estimated numbers from the Columbia River above McNary Dam (2,825,300) and the Snake River (480,091).

We estimate that 3,305,391 (2,825,300 + 480,091) spring/summer chinook salmon smolts will arrive at McNary Dam in 2001, and that 1,213,078 fish will be collected. Of the 1,213,078 smolts collected at McNary Dam, 57,448 (4.7%) will be wild (20,484 Upper Columbia River ESU and 36,964 Snake River ESU), 107,210 (8.8%) will be non-listed wild (all non-listed wild fish are from the Columbia River below the Upper Columbia River ESU), 122,078 (10.1%) will be listed hatchery (77,825 Upper Columbia River ESU and 44,253 Snake River ESU), and 926,341 (76.4%) will be non-listed hatchery fish (831,365 Columbia River and 94,976 Snake River). The ratio of Upper Columbia River ESU wild fish to Snake River ESU wild fish at McNary, John Day, and The Dalles Dams will be 35.7%:64.3% (28,618:51,642). The ratio of Upper Columbia River ESU listed hatchery fish to Snake River ESU listed hatchery fish at McNary, John Day, The Dalles, and Bonneville Dams will be 63.8%:36.2% (97,855:55,643).

We received some redd information from Oregon Department of Fish and Wildlife (ODFW) for the John Day River and from The Confederated Tribes of Warm Springs for the Deschutes River. Using the same redd to smolt calculation as described above, we added 263,625 wild unlisted fish between McNary and John Day Dams, and 94,050 wild unlisted fish between John Day and The Dalles Dams. However, because none of these fish are listed, there will be no effect on the ratios of Upper Columbia River ESU and Snake River ESU listed fish.

Lower Columbia River ESU

The Lower Columbia River ESU extends from the mouth of the Columbia River to the crest of the Cascade Range, excluding populations above Willamette Falls. This ESU includes wild spring-run and fall-run chinook salmon. No hatchery fish in this ESU are listed. The fall-run fish will be discussed below under the subyearling fall chinook salmon section. This ESU will introduce 352,186 listed wild spring chinook salmon into the Columbia River above Bonneville Dam, and an additional 3,017,676 spring chinook salmon below Bonneville Dam.

Estimate of Fish Arriving at Bonneville Dam

At Bonneville Dam, the ratio of Upper Columbia River ESU, Snake River ESU, and Lower Columbia River ESU listed wild fish will be 6.0%:11.0%:83.0% (25,756:46,478:352,186)

Fish transported from Snake River dams and McNary Dam are released below Bonneville Dam. The number of listed transport fish returned to the river will be 866,735 (396,977 wild and 469,758 listed hatchery) and 93,212 (16,439 wild and 76,773 listed hatchery) for the Snake River and Upper Columbia River ESUs, respectively. A total of 3,428,960 transported spring/summer chinook salmon will be released below Bonneville Dam.

Upper Willamette River ESU

The Upper Willamette River ESU contains spring chinook salmon populations above Willamette Falls. No hatchery fish in this ESU are listed. This ESU will introduce 564,430 listed wild spring chinook salmon to the Columbia River below Bonneville Dam.

The ratio of Upper Columbia River ESU, Snake River ESU, Lower Columbia River ESU, and Upper Willamette River ESU listed wild fish at Tongue Point will be 1.0%:10.0%:76.2%:12.8% (42,195:443,455:3,369,862:564,430). The ratio of Upper Columbia River ESU listed hatchery fish and Snake River ESU listed hatchery fish at Tongue Point will be 24.9%:75.1% (174,628:525,401).

Per-project survival was retained from last year's estimate (Table 2).

Summary

Tables 7 and 8 present a summary of the estimated number of fish that will be collected, or will be arriving (Columbia River dams above McNary Dam), at each of the dams during 2001. This information is derived from the data shown in Tables 1-2 and Appendix Table A1.

SUBYEARLING FALL CHINOOK SALMON ESTIMATES

To estimate the 2001 collection number at Lower Granite Dam, we used the 2000 collection number and the adult returns over the dam for 1999 and 2000. In 2000, 2,200,000 unmarked hatchery subyearling fall chinook salmon were released above Lower Granite Dam. Assuming a survival rate of 10.3% (the estimated survival rate of hatchery subyearling fall chinook salmon released above Lower Granite Dam in 2000), 226,783 (2,200,000 x 0.103) of these fish would have arrived at Lower Granite Dam. Assuming an FGE of 64.9% (derived from PIT-tagged hatchery subyearling fall chinook salmon in 2000), 147,182 (226,783 x 0.649) would have been collected at Lower Granite Dam. Through 31 December 2000, 583,985 unclipped (and without a coded-wire tag) subyearling chinook salmon had been collected at Lower Granite Dam. By removing the estimated 147,182 unmarked hatchery subyearling fall chinook salmon, we estimate that 436,803 (583,985 - 147,182) wild subyearling fall chinook salmon were collected at Lower Granite Dam in 2000. These wild subyearling fall chinook salmon were from the 1999 adult return. The adult count over Lower Granite Dam in 1999 was 3,385. Of these, 1,484 were hatchery fish that were returned to Lyons Ferry Hatchery and 1,901 adults were passed above Lower Granite Dam. The 2001 outmigration will be the result of the 2000 adults passed over Lower Granite Dam. Through 31 December 2000, 3,602 adults had been counted in the adult ladder. Of these, 1,402 fish were returned to Lyons Ferry Hatchery, leaving 2,200 adults that were passed above Lower Granite Dam. The 2000 count of 2,200 adults represents a 115.7% increase over the 1999 count (1,901). We applied this increase to the 2000 subyearling collection number to arrive at the estimated 2001 collection number.

$$\begin{pmatrix}\text{total wild fall chinook}\\ \text{collected at Granite}\end{pmatrix} = \begin{pmatrix}\text{wild fall chinook}\\ \text{collected in 2000}\end{pmatrix} \times \begin{pmatrix}\text{\% change between adult counts}\\ \text{for 2000 and 2001 outmigrations}\end{pmatrix} =$$

$$505{,}381 = 436{,}803 \times 1.157$$

We estimated the total number of wild subyearling fall chinook salmon arriving at Lower Granite Dam by dividing the number of wild fish collected by the FGE at Lower Granite Dam. The average estimated FGE for PIT-tagged hatchery subyearling fall chinook salmon arriving at Lower Granite Dam from 1995-2000 is 53.9%.

$$\text{total wild fall chinook} = \text{total wild fall chinook collected/FGE} = 937{,}627 = 505{,}381/0.539$$

The Nez Perce Tribe will release 1,500,000 unlisted supplementation subyearling fall chinook salmon in the Clearwater River basin. Of these fish, 1,200,000 will be unmarked.

Assuming a survival rate of 35.4% (the average estimated survival rate of PIT-tagged hatchery subyearling fall chinook salmon released above Lower Granite Dam from 1995-2000), 424,800 (1,200,000 x 0.354) of these fish will arrive at Lower Granite Dam. By adding these fish to the total number of wild fall chinook salmon (937,627), we estimate that 1,362,427 unmarked subyearling fall chinook salmon will arrive at Lower Granite Dam. The percentage of unmarked subyearling fall chinook salmon that are wild will be 68.8% (937,627/1,362,427). Of the 300,000 (1,500,000 - 1,200,000) marked hatchery subyearling fall chinook salmon to be released above Lower Granite Dam, 106,200 (300,000 x 0.354) will arrive at Lower Granite Dam.

For research purposes, 150,000 PIT-tagged Lyons Ferry Hatchery subyearling fall chinook salmon will be released above Lower Granite Dam in 2001. Using the survival rate 35.4%, we estimate that 53,100 (150,000 x 0.354) research fish from Lyons Ferry Hatchery will reach Lower Granite Dam in 2001. We added the total unmarked fish (1,362,427), the marked fish (106,200), and the research fish (53,100) to determine the total number of subyearling fall chinook arriving at Lower Granite Dam (1,521,727).

Knowing the total number of fish and the number of wild fish, we estimated the number of fish collected at Lower Granite Dam, and the percentage composition of wild fish arriving at Lower Granite Dam.

fall chinook collected = total fall chinook x FGE =
820,211 = 1,521,727 x 0.539

% wild fish = total wild fall chinook/total fall chinook =
61.6% = 937,627/1,521,727

NMFS has conducted subyearling fall chinook salmon survival tests since 1995. As part of these tests, we estimated actual FGE's for McNary Dam (factoring in effects of spill). To more accurately estimate the collection number at McNary Dam, we averaged these actual FGE's for 1995-2000. We also averaged the number of fall chinook salmon adults crossing McNary Dam for each of the brood years (1994-1999) and the number of juvenile subyearling fall chinook salmon collected at McNary Dam (1995-2000). The 2000 count of 66,378 adults represents 0.913% of the average for 1994-1999 count (72,679). We applied this change (0.913) to the average 1995-2000 subyearling collection number (6,115,078) to arrive at an estimated 2001 collection number (5,583,066).

Based on the NMFS subyearling fall chinook salmon survival studies conducted in 1995-2000, per-project survival was set at

75%. We set the FGEs in our formulas at Little Goose, Lower Monumental, and McNary Dams, based on 1995-2000 NMFS fall chinook survival study results, to 48.0%, 44.3%, and 47.5%, respectively.

Lower Columbia River ESU

The Lower Columbia River wild tule and late-run bright fall chinook salmon have been added to the list of protected species. No hatchery fish are listed in this ESU.

To determine the number of wild outmigrants from this ESU, we assumed that 50% of the adults counted in the spawning areas were female and that every female spawned successfully. We used average fecundity and set the egg-to-smolt survival rate at 15%, the same used for spring/summer chinook salmon.

Based on this method of estimation, we estimate that 2,345,376 tule fall chinook salmon will outmigrate from above Bonneville Dam. No late-run bright fish will enter the Columbia River above Bonneville Dam. Additionally, 5,547,788 tule fall chinook salmon and 4,290,238 late-run bright fall chinook salmon will enter the Columbia River below Bonneville Dam.

The ratio of Snake River ESU and Lower Columbia River ESU (tule fall chinook) listed wild fish at Bonneville Dam will be 0.4%:99.6% (9,831:2,345,376).

Fish transported from Snake River dams and McNary Dam are released below Bonneville Dam. The number of listed transport fish returned to the river will be 725,833, all from the Snake River ESU. A total of 6,507,934 transported subyearling fall chinook salmon will be released below Bonneville Dam.

The ratio of Snake River ESU, Lower Columbia River ESU (tule fall chinook), and Lower Columbia River ESU (late-run bright fall chinook) listed wild fish at Tongue Point will be 5.8%:61.0%:33.2% (750,380:7,893,164:4,290,238).

Summary

Table 7 presents a summary of the estimated number of fish that will be collected, or will be arriving (Columbia River dams above McNary Dam), at each of the dams during 2001. This information is derived from the data shown in Table 2.

SOCKEYE SALMON ESTIMATES

The sockeye salmon collection count at Lower Granite Dam was based on IDFG's estimate of wild and hatchery-reared sockeye salmon smolts exiting the upper Salmon River in 2001 and their estimates of survival to Lower Granite Dam. IDFG estimates that 2,500 wild fish (survival to Lower Granite Dam of 39.5%), 21,100 hatchery fish that have overwintered in the lakes (survival to Lower Granite Dam of 37.067%), and 13,000 hatchery fish released in spring 2001 (survival to Lower Granite Dam of 50.0%) will outmigrate in spring 2001. All of these fish are listed as endangered.

listed sockeye (wild and hatchery) to Lower Granite Dam =
IDFG's estimate x survival rate =
15,309 = (2,500 x 0.395) + (21,100 x 0.37067) + (13,000 x 0.5)

To determine the percentage of wild sockeye salmon collected at Lower Granite Dam, we had to estimate the number of kokanee arriving at Lower Granite Dam. In 2000, we estimated that 3,764 wild Redfish Lake sockeye salmon would be collected at Lower Granite Dam. During that outmigration, spill from Dworshak Dam released kokanee that were collected at Lower Granite Dam. The total collection of wild *Oncorhynchus nerka* salmon at Lower Granite Dam for 2000 (through 31 December 2000) was 4,184, 420 of which (4,184 - 3,764) were kokanee. With an FGE of 24.4% (the 2000 estimate), 1,721 (420/0.244) kokanee reached Lower Granite Dam. Assuming the same amount of spill from Dworshak Dam in 2001 with a release of the same number of kokanee, we estimated the total number of wild *O. nerka* arriving at Lower Granite Dam to be 2,709 (1,721 + 988 (2,500 x 0.395)). We then estimated the percentage of wild *O. nerka* arriving at Lower Granite Dam that will be listed Snake River sockeye salmon.

% listed wild sockeye =
listed wild sockeye/total wild *O. nerka* to Lower Granite Dam =
36.5% = 988/2,709

A total of 17,030 (15,309 listed sockeye + 1,721 kokanee) *O. nerka* will arrive at Lower Granite Dam.

% total listed sockeye =
total listed sockeye/total *O. nerka* to Lower Granite Dam =
89.9% = 15,309/17,030

An FGE of 31.0% (average for 1998-2000) was used to estimate the number of *O. nerka* smolts reaching Lower Granite Dam that will be collected.

O. nerka salmon collected = total *O. nerka* salmon x FGE =
5,279 = 17,030 x 0.310

Because of extreme year-to-year variability, the count used at McNary Dam for 2001 is based on the average of the counts at the dam from 1985 to 2000 (583,008). Project survival was set at the yearling chinook salmon level (Table 2).

Summary

Table 7 presents a summary of the estimated number of fish that will be collected, or will be arriving (Columbia River dams above McNary Dam), at each of the dams during 2001. This information is derived from the data shown in Table 2.

STEELHEAD ESTIMATES

Because of the time of year that steelhead spawn, it is very difficult to obtain redd count information. All of our steelhead estimates, not otherwise explained, are based on adult counts in the spawning areas. We assumed that 65% of the adults were females and that every female spawned successfully. To estimate the number of outmigrants, we used average fecundity estimates, and assigned an egg-to-smolt survival rate of 1%. This survival rate is conservative as all rates we calculated or found in the literature were from 0.5% to 0.75%.

Snake River Steelhead ESU

Prior to the 2000 outmigration, nearly all hatchery steelhead were fin-clipped, allowing us to use the juvenile collection numbers at Lower Granite Dam without making any adjustments for unclipped hatchery fish. Because it was known that a large number of unclipped steelhead were to be released for the 2000 outmigration, WDFW, which handles the Smolt Monitoring Program's duties at Lower Granite Dam, not only recorded the number of unclipped steelhead collected but also the number of unclipped steelhead that had fin erosion, a strong indicator that a fish is of hatchery origin. Based on the information provided by WDFW (Fred Mensik, Pers. Comm., March 2001), we determined that 450,239 wild steelhead were collected at Lower Granite Dam in 2000 (307,284 of the 757,523 unclipped steelhead collected at Lower Granite Dam in 2000 had fin erosion). We applied the 2000 estimated FGE (54.3%) to the collection number to determine that 829,169 (450,239/0.543) wild steelhead arrived at Lower Granite Dam in 2000.

To our knowledge, no research has been conducted on the age-class distribution of migrating juvenile steelhead in the Snake River; however, there has been research on the mid-Columbia River (Pevan et al. 1994[1]). Pevan's research showed that in the mid-Columbia River, migrating steelhead were 0.7% age-1, 43.2% age-2, 46.4% age-3, and 8.6% age-4 smolts. The age-class of the remainder of smolts (1.1%) was greater than age-4, up to age-7. Because of this age-class breakdown, we decided to base our estimates on age-classes 1 to 4. Because steelhead spawn in the spring, our annual counts were from 1 July to 30 June, rather than by calendar year. Using the adult counts at Lower Granite Dam of the 4 years that comprised the 2000 wild smolt outmigration

[1] Pevan, C. M., R. R. Whitney, and K. R. Williams. 1994. Age and length of steelhead smolts from the Mid-Columbia River Basin, Washington. N. Am. J. Fish. Manage. 14:77-86.

(1996-1999 brood years, 1 July 1995-30 June 1999), and applying the smolt age-class percentages to the adult counts for each of these four years, we estimated that 8,934 of the adults passing Lower Granite Dam produced the 2000 steelhead outmigration. We performed the same calculation to estimate the number of adults from the 4 years (1997-2000 brood years) producing the 2001 wild outmigration. We calculated that the 2001 wild outmigration will be based on 8,895 adults, or 99.6% of the number of fish producing the 2000 outmigration. We applied the change in the number of adults to the number of wild steelhead that arrived at Lower Granite Dam in 2000 (829,169) to determine the estimated 2001 arrival number.

$$\left(\begin{array}{c}\text{total wild steelhead}\\ \text{arriving at Lower Granite}\end{array}\right) = \left(\begin{array}{c}\text{wild steelhead}\\ \text{arriving in 2000}\end{array}\right) \times \left(\begin{array}{c}\text{\% change between adult counts}\\ \text{for 2000 and 2001 outmigrations}\end{array}\right) =$$

$$825{,}853 = 829{,}169 \times 0.996$$

For the steelhead hatchery release numbers, we used IDFG's, ODFW's, and WDFW's estimates of hatchery releases in Idaho, Oregon, and Washington. We estimate that 9,114,500 hatchery smolts will be released from Idaho (7,720,000), Oregon (1,194,500), and Washington (200,000 in the Grande Ronde River). In the Snake River, no hatchery steelhead are listed under the ESA.

In order to estimate how many hatchery smolts will reach Lower Granite Dam, we attempted to use the survival estimates for the 1993-6 outmigrations (from the NMFS survival study). We found that survival estimates have only been made for two hatcheries, Dworshak National Fish Hatchery (77.2%) and Clearwater Hatchery (68.1%). We applied the survival estimate from Dworshak National Fish Hatchery to the other hatcheries that did not have estimates. Using these estimates with the 2001 projected release numbers for each hatchery, we estimated how many total hatchery fish will arrive at Lower Granite Dam. We estimate that 6,970,874 or 76.5% of the 9,114,500 hatchery fish released will arrive at the dam.

Knowing the numbers of hatchery and wild fish arriving at Lower Granite Dam, we estimated the percentage composition of listed wild fish arriving at the dam.

$$\text{total smolts} = \text{total hatchery fish} + \text{wild fish} = 7{,}796{,}727 = 6{,}970{,}874 + 825{,}853$$

$$\text{\% wild fish to Lower Granite Dam} = \text{wild fish/total smolts} = 10.6\% = 825{,}853/7{,}796{,}727$$

We set FGEs at Lower Granite and Little Goose Dams at 48% and 49.4%, respectively. Using an FGE of 48%, the total collection at Lower Granite Dam will be 3,742,429 (7,796,727 x 0.48), based on 7,796,727 smolts arriving at the dam. Wild and hatchery fish, will comprise 396,409 (825,853 x 0.48) and 3,346,020 (3,742,429 - 396,409) of the total collection, respectively.

Wild/natural Tucannon River drainage fish are listed within the Snake River ESU. In spring 2001, 25,000 wild fish are expected to outmigrate from the Tucannon River. In addition, 195,000 hatchery fish will be released into the Tucannon River. The Tucannon River joins the Snake River between Little Goose and Lower Monumental Dams. Because of the short distance from the confluence to Lower Monumental Dam, we assumed no mortality of these fish prior to Lower Monumental Dam. The estimates shown in Table 5 and Tables 9-10 reflect the addition of these fish above Lower Monumental Dam.

WDFW will release 137,350 hatchery steelhead into the Touchet River, a tributary of the Walla Walla River and 125,000 steelhead into the Walla Walla River. The Walla Walla River enters the Columbia River above McNary Dam. For these fish, survival to McNary Dam was set at 100%.

Over the past four years, all PIT-tagged fish bypassed at the collection dams (Lower Granite, Little Goose, Lower Monumental, and McNary Dams) have been returned to the river to continue migrating inriver. This return of fish to the river requires adjustment of our estimates of the number of listed fish that reach McNary Dam. We estimated the number of fish that will be PIT tagged for 2001 and assumed that 100% of them would be returned to the river at each collector dam. A detailed description of how we estimated the impact of returning PIT-tagged fish to the river is presented in Appendix B. We estimated that 4,836 PIT-tagged steelhead from the Snake River (including 1,337 wild fish) will be collected at McNary Dam because they were returned to the river at an upstream dam(s). These numbers represent collected fish. Dividing the collected number by the FGE at McNary Dam, we determined that 7,682 wild (1,337/0.174) will arrive at McNary Dam and must be added to the number of fish that were estimated to reach McNary Dam as a result of not having been collected at an upstream dam (column "Listed fish to McNary", Table 5).

Upper-Columbia River ESU Steelhead

Very little is known regarding wild steelhead in the Columbia River above the confluence with the Yakima River. Also, little is known regarding dam passage of smolts at the dams above McNary Dam. Because of this lack of information, the estimates of wild steelhead from the listed Upper Columbia River ESU are based on what little information is available and on broad generalizations based on this information. No FGE's have been established for the dams in this reach, so the numbers presented in this section of the memorandum (and in Tables 9 and 10) are the number of fish arriving at the dam, not collection numbers (unless otherwise noted in the text).

As mentioned above, Pevan et al. (1994) showed that migrating steelhead were 0.7% age-1, 43.2% age-2, 46.4% age-3, and 8.6% age-4 smolts. The age-class of the remainder of smolts (1.1%) was greater than age-4, up to age-7. Because of this age-class breakdown, we decided to base our estimates on age-classes one to four.

We based our estimates of wild fish on counts collected at Rock Island Dam by the Fish Passage Center. During the 2000 outmigration, 10,036 wild steelhead smolts were counted in the Smolt Monitoring Program's sample. It is estimated that the sample represents 3-5% of the fish passing the dam. Using a 4% sample rate, we estimated that 250,900 wild steelhead passed Rock Island Dam in 2000.

We then examined the adult counts at Rock Island Dam. Because steelhead spawn in the spring, our annual counts were from 1 July to 30 June, rather than by calendar year. Using the adult counts of the 4 years that comprised the 2000 wild smolt outmigration (1996-1999 brood years, 1 July 1995-30 June 1999), and applying the smolt age-class percentages to the adult counts for each of these four years, we estimated that 7,024 of the adults passing Rock Island Dam produced the 2000 steelhead outmigration. We performed the same calculation to estimate the number of adults from the 4 years (1997-2000 brood years) producing the 2001 wild outmigration. We calculated that the 2001 wild outmigration will be based on 6,280 adults, or 89.4% of the number of fish producing the 2000 outmigration. We applied the change in the number of adults to the 2000 Rock Island Dam collection to arrive at the estimated 2001 collection number.

$$\left(\begin{array}{c}\text{total wild steelhead}\\ \text{collected at Rock Island}\end{array}\right) = \left(\begin{array}{c}\text{wild steelhead}\\ \text{collected in 2000}\end{array}\right) \times \left(\begin{array}{c}\text{\% change between adult counts}\\ \text{for 2000 and 2001 outmigrations}\end{array}\right) =$$

$$8{,}972 = 10{,}036 \times 0.894$$

Since this represents 4% of the fish passing the dam, we estimate that 224,300 wild steelhead smolts will pass the dam in 2001. Using the smolt age-class percentages, we estimate that 1,570 smolts will be age-1, 98,898 will be age-2, 104,075 will be age-3 and 19,290 will be age-4.

To determine the number of wild smolts passing the two dams above Rock Island Dam (Rocky Reach and Wells Dams), we used the estimate of wild smolts passing Rock Island Dam (224,300) and the adult counts at all three dams.

By comparing the adult counts at each of the three dams for the four years that will produce the 2001 outmigration (1997-2000), we calculated the number of adults "lost" between each dam. We assigned this "loss" to adults migrating up rivers between the dams. The difference in adult counts between dams varied between years, so we applied the age-class percentages to each year's differences between dams to determine the number of wild smolts added from the rivers between the dams.

From Rock Island Dam to McNary Dam, the only adjustment made to the wild steelhead smolt count was for per-project survival (0.9%).

To determine the number of hatchery smolts arriving at each dam in 2001, we used the outplanting data for the three years comprising the 2001 outmigration (1999-2001). Because hatchery fish are larger than equivalent age-class wild fish, we assigned age-2 status to hatchery fish released in 2001, age-3 to those released in 2000, and age-4 to those release in 1999. Most of the hatchery outplants (60.6%) will be of listed hatchery stocks.

Because there are no survival data for the various hatcheries releasing fish in this section of the Columbia River, we assumed that all fish released survived to the first dam. We again applied the age-class percentages to the number of fish released each of the 3 years to determine the number of hatchery fish that would outmigrate in 2001. Beginning at Wells Dam and assuming 90% per-project survival, we determined both the number of listed hatchery and the total number of hatchery fish reaching each dam through McNary Dam.

Mid-Columbia River ESU Steelhead

The Mid-Columbia River wild summer-run and winter-run steelhead have been added to the list of protected species. There are no listed hatchery stocks in this ESU. Only summer steelhead from the Yakima River enter the Columbia River above McNary Dam.

Based on our estimates as explained at the beginning of this section, 69,433 summer steelhead will enter the Columbia River above McNary Dam in 2001. An additional 228,114 wild summer steelhead from this ESU will be added between McNary and John Day Dams, and 65,160 wild summer steelhead and 16,557 wild winter steelhead will be added between John Day and The Dalles Dams.

Estimate of Fish Arriving at McNary Dam

McNary Dam is the first dam on the Columbia River below the confluence of the Snake River. To obtain an estimate of the number of steelhead smolts arriving at McNary Dam, we added the estimated numbers from the Upper Columbia River (1,038,930), Mid-Columbia (69,433) and the Snake River (820,363) ESUs.

We estimate that 1,928,726 (1,038,930 + 69,433 + 820,363) steelhead smolts will arrive at McNary Dam in 2001, and that 335,598 fish will be collected. Of the 335,598 smolts collected at McNary Dam, 56,602 (16.9%) will be wild (28,452 Upper Columbia River ESU, 16,069 Snake River ESU, and 12,081 Mid-Columbia River ESU), 93,642 (27.9%) will be listed hatchery (Upper Columbia River ESU), and 185,355 (55.2%) will be unlisted hatchery fish (58,680 Columbia River and 126,675 Snake River). The ratio of Upper Columbia River ESU wild fish, Snake River ESU wild fish and Mid-Columbia River ESU wild fish at McNary, John Day, and The Dalles Dams will be

	McNary Dam	John Day	The Dalles
Upper Columbia	50.3 (28,452)	27.2 (121,557)	22.9 (109,401)
Snake River	28.4 (16,069)	15.3 (68,652)	12.9 (61,787)
Mid-Columbia			
summer	21.3 (12,081)	57.5 (256,919)	60.7 (289,871)
winter	—	—	3.5 (16,557)

All listed hatchery fish will be from the Upper Columbia River ESU.

Lower Columbia River ESU

All of our estimates for the number of wild steelhead outmigrating from the Lower Columbia River ESU are based on Washington Department of Fish and Wildlife's (WDFW) estimates for the Washington shore rivers and streams (Dan Rawdings, WDFW, Pers. commun., December 1999). We attempted to obtain information from Oregon Department of Fish and Wildlife, but the information was not available.

There are no listed hatchery fish in the Lower Columbia River ESU.

According to WDFW, 17,000 steelhead are expected to outmigrate from Washington upstream from Bonneville Dam to the Wind River. WDFW also estimates that 17,000 steelhead will outmigrate from Oregon upstream from Bonneville Dam to the Hood River. As with hatchery fish released into the Bonneville Dam pool, we have assumed no mortality of these fish to Bonneville Dam. This will add 34,000 wild steelhead to the number of fish arriving at Bonneville Dam. The effects of this are shown in the "Bonneville Dam" lines in Tables 9 and 10. The ratio of the various ESUs will be

	Bonneville Dam
Upper Columbia	21.2 (98,461)
Snake River	12.0 (55,608)
Mid-Columbia	
summer	56.2 (260,884)
winter	3.2 (14,901)
Lower Columbia	7.3 (34,000)

All listed hatchery fish will be from the Upper Columbia River ESU.

Another 193,000 wild steelhead are expected to enter the Columbia River from Washington and Oregon downstream from Bonneville Dam to the Cowlitz River.

Fish transported from Snake River dams and McNary Dam are released below Bonneville Dam. The number of listed transport fish returned to the river will be 699,515 (all wild), 121,422 (27,780 wild and 93,642 listed hatchery), and 11,796 (all wild) for the Snake River, Upper Columbia River, and Mid-Columbia River (summer-run) ESUs, respectively. A total of 6,778,946 transported steelhead will be released below Bonneville Dam.

Upper Willamette River ESU

The Upper Willamette River wild summer-run steelhead have been added to the list of protected species. There are no listed hatchery stocks in this ESU.

Based on our estimates as explained at the beginning of this section, 183,997 summer steelhead will enter the Columbia River in 2001.

At Tongue Point the ratios of the various ESUs will be

	Tongue Point
Upper Columbia	8.0 (126,241)
Snake River	47.8 (755,123)
Mid-Columbia	
summer	17.3 (272,680)
winter	0.9 (14,901)
Lower Columbia	14.4 (227,000)
Upper Willamette	11.6 (183,997)

All listed hatchery fish will be from the Upper Columbia River ESU.

Summary

Tables 9 and 10 summarize the estimated number of steelhead that will be collected, or will be arriving (Columbia River dams above McNary Dam), at each of the collection dams during 2001. This information is derived from the data shown in Tables 4-5 and Appendix Table B1.

CHUM ESTIMATES

Columbia River ESU

Wild chum salmon in the Columbia River have been added to the list of protected species. No hatchery fish are listed.

We only have estimates for wild production beginning below Bonneville Dam, so only research locations below Hardy Creek (just below Bonneville Dam) are affected. To determine the number of wild outmigrants, we assumed that 50% of the adults counted in the spawning areas were female and that every female spawned successfully. We used average fecundity and set the egg-to-smolt survival rate at 45%. The survival rate was based on the literature which suggests that 80%-85% of the eggs hatch and that 45%-50% of the resulting parr survive to outmigrate.

We estimate that 301,320 wild chum salmon will outmigrate from above Grays River, affecting all research above Grays River. We estimate that another 622,080 wild chum salmon will outmigrate from Grays River. Also, 100,000 hatchery chum salmon will be released into the Grays River and 50,000 hatchery fish will be released into the Chinook River.

Summary

Table 9 summarizes the estimated number of chum salmon that will be arriving at Tongue Point during 2001.

Full Transportation Scenario

With basin-wide projections of a low flow year in 2001, spill is expected to be low or non-existent. Based on this, the full transportation scenario (with no spill) will provide the best estimates of fish numbers.

The estimates shown in Table 3 were derived using the same methodology utilized under the Transportation with Spill Scenario, with one major difference. The number of fish removed at each dam under the Transportation with Spill Scenario was based on an FGE value that adjusted for spill. For our estimates under the Full Transportation Scenario, we used the FGE values developed during testing of the diversion screens installed in each of the turbine intakes. Using the results from these tests, the FGEs for spring/summer chinook salmon and sockeye salmon were changed to 60%, 65%, 50%, and 80% at Lower Granite, Little Goose, Lower Monumental, and McNary Dams, respectively. Subyearling fall chinook salmon FGEs were changed to 55%, 60%, 40%, and 65% at Lower Granite, Little Goose, Lower Monumental, and McNary Dams, respectively. Steelhead FGEs were changed to 80%, 90%, 65%, and 90% at Lower Granite, Little Goose, Lower Monumental, and McNary Dams, respectively. Using the same formulas as under the Transportation with Spill Scenario, we derived the values found in Tables 3 and 6-10.

Because the adjusted FGE at Lower Granite Dam was changed from 42.6% to 60% for yearling spring/summer chinook and sockeye salmon, the total number of fish collected at Lower Granite Dam will be 1,740,616 (2,901,026 x 0.60) spring/summer chinook salmon and 10,218 (17,030 x 0.60) *O. nerka* salmon.

Because more PIT-tagged fish will be collected at the upstream dams, the number of PIT-tagged fish that are returned to the river and subsequently collected at McNary Dam will be different under this scenario. The effects of this are shown in Appendices A and B.

As under the Transportation with Spill Scenario, to estimate the number of spring/summer smolts arriving at McNary Dam, we added the estimated numbers from the Columbia River above McNary (2,825,300) and the Snake River (232,836).

$$2{,}825{,}300 + 232{,}836 = 3{,}058{,}136$$

Tables 9 and 10 show the changes in percentages of listed fish at each dam.

Table 1. Estimated percentage composition of Snake River spring/summer chinook salmon arriving at Lower Granite Dam from listed hatcheries compared with total hatchery releases projected for spring 2001.

Hatchery	Total hatchery releases[a] 2001	Survival to Lower Granite Dam Mean[b] (%)	Fish to Lower Granite Dam
Dworshak[c]	333,000	77.4	257,825
Kooskia[c]	80,000	65.9	52,690
Lookingglass			
Imnaha[d]	123,000	63.9	78,650
Grande Ronde[c]	276,500	67.9	187,640
Clearwater[c]	849,993	60.2	511,908
Rapid River[c]	730,000	61.9	451,870
Sawtooth[d]	58,600	34.7	20,317
McCall[c,d]	1,345,965	52.8	710,165
Pahsimeroi[d]	283,400	53.6	151,761
Totals			
All stocks	4,080,458		2,422,826
Listed stocks	884,270		513,697
Percent of listed stocks	21.671%		21.2024%

[a] Data from IDFG and ODFW.

[b] Mean survival estimate made from PIT-tag detections of marked hatchery fish releases as part of the NMFS/UW survival studies for 1993-2000.

[c] Non-listed stocks.

[d] Listed stocks in 2001 (only 142,770 of the 1,345,965 McCall Hatchery fish are listed).

Table 2. Estimate of listed threatened and endangered species arriving at McNary Dam during outmigration year 2001 under past transportation and spill conditions.

Yearling spring/summer chinook salmon

Snake River ESU

Rearing type	Total Collection* Granite	McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon**	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Wild	1,235,837	1,213,078	16.5	478,200	0.426	0.443	0.385	0.367	0.9	100,720	36,964	3.05
Listed hatchery***	1,235,837	1,213,078	17.707	513,697	0.426	0.443	0.385	0.367	0.9	120,581	44,253	3.65

Upper Columbia River ESU

Rearing type	Number of listed fish passing dam Wells	Rocky Reach	Rock Island	Of dam total, % listed fish Wells	Rocky Reach	Rock Island	FGE McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Wild****	25,650	42,323	76,565	7.7	6.7	4.0	0.367	0.9	55,816	20,484	1.69
Listed hatchery	276,407	248,766	290,889	83.0	39.6	15.1	0.367	0.9	212,058	77,825	6.42

Subyearling fall chinook salmon

Rearing type	Total Collection* Granite	McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Wild****	820,211	5,583,066	61.6	937,627	0.539	0.480	0.443	0.475	0.75	42,119	20,007	0.36

Sockeye salmon

Rearing type	Total Collection* Granite	McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Wild and listed hatchery*****	5,279	583,008	89.89	15,309	0.310	0.289	0.321	0.218	0.9	3,346	729	0.13

*Note: Total Collection is the total number of fish collected of that species or run, regardless of rearing type.

**Note: Listed wild and hatchery spring chinook salmon enter the Snake River above Lower Monumental Dam. WDFW predicts that 16,000 wild and 100,000 listed hatchery fish will outmigrate from the Tucannon River in 2001 (Mark Schurk, WDFW, Pers. commun., February 2001)

***Note: Based on 2001 hatchery releases, it was estimated that 21.202% of the hatchery fish arriving at Lower Granite Dam are products of a listed hatchery (Table 1). Because Table 2 is based on the total collection at Lower Granite Dam, which includes both wild and hatchery (listed and unlisted) fish, this estimate of 21.202% of all hatchery fish was adjusted to 17.42% of the total collection at Lower Granite Dam.

****Note: Estimated values based on the average collection numbers from 1995-2000 (Fish Passage Center Weekly Reports), and on the average number of adult returns from 1994-1999 and the 2000 adult returns (FPC Weekly Reports 1994-2000).

*****Note: The Lower Granite Dam estimate is based on IDFG's estimate of 2,500 wild sockeye salmon smolts (survival = 0.395), 21,100 hatchery fish that overwintered in the lakes (survival = 0.37067), and 13,000 hatchery fish released spring 20001 (survival = 0.50) leaving the upper Salmon River in 2001 (Paul Kline, IDFG, Pers. commun., January 2001). The McNary Dam estimate is the average collection count at McNary Dam from 1985-2000 (Annual Fish Passage Reports 1985-2000, and WDFW's 2000 fish counts).

1 The FGE used in this table is adjusted for spill conditions, and PIT-tag detection efficiency at a dam. This estimate was obtained from the NMFS survival studies conducted in 1995-2000 (Steven G. Smith, NMFS, Pers. commun., January 2001).

Formulas:

a) Listed fish to Granite = $((\text{Collection}_{\text{Granite}})/(\text{FGE}_{\text{Granite}}))\text{x}(\text{Of Granite Total \% Listed Fish})$

b) Listed Fish to McNary = $(\text{Listed Fish to Granite})\text{x}(1\text{-}\text{FGE}_{\text{Granite}})\text{x}(\text{Project Survival})\text{x}(1\text{-}\text{FGE}_{\text{Goose}})\text{x}(\text{Project Survival})\text{x}(1\text{-}\text{FGE}_{\text{Low Mon}})\text{x}(\text{Project Survival})^2$ + $(\text{listed Tucannon fish})\text{x}(1\text{-}\text{FGE}_{\text{Low Mon}})\text{x}(\text{Project Survival})^2$ +(PIT-tagged fish)

where: listed Tucannon fish = 16,000 wild and 100,000 hatchery
PIT-tagged fish = fish collected at Snake River dams, returned to the river, and subsequently arrived at McNary Dam; See Appendix Table A1.

Table 3. Estimate of listed threatened and endangered species arriving at McNary Dam during outmigration year 2001 under full transportation conditions (no spill).

Yearling spring/summer chinook salmon

Snake River ESU

Rearing type	Total Collection* Granite	Total Collection* McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon**	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	Of Fish Collected at McNary % Listed Fish
Wild	1,740,616	2,446,509	16.5	478,200	0.60	0.65	0.50	0.80	0.9	64,625	51,700	2.11
Listed hatchery***	1,740,616	2,446,509	17.707	513,697	0.60	0.65	0.50	0.80	0.9	68,563	54,850	2.24

Upper Columbia River ESU

Rearing type	Number of listed fish passing dam Wells	Rocky Reach	Rock Island	Of dam total, % listed fish Wells	Rocky Reach	Rock Island	FGE McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	Of Fish Collected at McNary % Listed Fish
Wild****	25,650	42,323	76,565	7.7	6.7	4.0	0.80	0.9	55,816	44,653	1.83
Listed hatchery	276,407	248,766	290,889	83.0	39.6	15.1	0.80	0.9	212,058	169,646	6.93

Subyearling fall chinook salmon

Rearing type	Total Collection* Granite	Total Collection* McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	Of Fish Collected at McNary % Listed Fish
Wild****	836,950	7,632,121	61.6	937,626	0.55	0.60	0.40	0.65	0.75	34,740	22,581	0.30

Sockeye salmon

Rearing type	Total Collection* Granite	Total Collection* McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	Of Fish Collected at McNary % Listed Fish
Wild and listed hatchery*****	10,218	583,008	89.89	15,309	0.60	0.65	0.50	0.80	0.9	703	562	0.10

*Note: Total Collection is the total number of fish collected of that species or run, regardless of rearing type.

**Note: Listed wild and hatchery spring chinook salmon enter the Snake River above Lower Monumental Dam. WDFW predicts that 16,000 wild and 100,000 listed hatchery fish will outmigrate from the Tucannon River in 2001 (Mark Schurk, WDFW, Pers. commun., February 2001)

***Note: Based on 2001 hatchery releases, it was estimated that 21.202% of the hatchery fish arriving at Lower Granite Dam are products of a listed hatchery (Table 1). Because Table 3 is based on the total collection at Lower Granite Dam, which includes both wild and hatchery (listed and unlisted) fish, this estimate of 21.202% of all hatchery fish was adjusted to 17.42% of the total collection at Lower Granite Dam.

****Note: Estimated values based on the average collection numbers from 1995-2000 (Fish Passage Center Weekly Reports), and on the average number of adult returns from 1994-1999 and the 2000 adult returns (FPC Weekly Reports 1994-2000).

*****Note: The Lower Granite Dam estimate is based on IDFG's estimate of 2,500 wild sockeye salmon smolts (survival = 0.395), 21,100 hatchery fish that overwintered in the lakes (survival = 0.37067), and 13,000 hatchery fish released spring 20001 (survival = 0.50) leaving the upper Salmon River in 2001 (Paul Kline, IDFG, Pers. commun., January 2001). The McNary Dam estimate is the average collection count at McNary Dam from 1985-2000 (Annual Fish Passage Reports 1985-2000, and WDFW's 2000 fish counts).

1 The FGE used in this table is adjusted for spill conditions, and PIT-tag detection efficiency at a dam. This estimate was obtained from the NMFS survival studies conducted in 1995-2000 (Steven G. Smith, NMFS, Pers. commun., January 2001).

Formulas:

a) Listed fish to Granite = $((\text{Collection}_{\text{Granite}})/(\text{FGE}_{\text{Granite}}))\text{x}(\text{Of Granite Total \% Listed Fish})$

b) Listed Fish to McNary = $(\text{Listed Fish to Granite})\text{x}(1\text{-}\text{FGE}_{\text{Granite}})\text{x}(\text{Project Survival})\text{x}(1\text{-}\text{FGE}_{\text{Goose}})\text{x}(\text{Project Survival})\text{x}(1\text{-}\text{FGE}_{\text{Low Mon}})\text{x}(\text{Project Survival})^2$ + $(\text{listed Tucannon fish})\text{x}(1\text{-}\text{FGE}_{\text{Low Mon}})\text{x}(\text{Project Survival})^2$ +(PIT-tagged fish)

where: listed Tucannon fish = 16,000 wild and 100,000 hatchery
PIT-tagged fish = fish collected at Snake River dams, returned to the river, and subsequently arrived at McNary Dam; See Appendix Table A1.

Table 4. Estimated percentage composition of Snake River steelhead arriving at Lower Granite Dam from total hatchery releases projected for spring 2001. No hatchery in the Snake River ESU is listed.

Hatchery	Total hatchery releases[a] 2001	Survival to Lower Granite Dam Mean (%)	Fish to Lower Granite Dam
Dworshak	2,000,000	77.2[b]	1,544,000
Clearwater	720,000	68.1[b]	490,320
Hagerman	1,200,000	77.2[c]	926,400
Magic Valley	2,000,000	77.2[c]	1,544,000
Niagara Springs	1,800,000	77.2[c]	1,389,600
Irrigon (released into Grande Ronde)	1,194,500	77.2[c]	922,154
Lyons Ferry (released into Grande Ronde)	200,000	77.2[c]	154,400
Totals All stocks	9,114,500		6,970,874

[a] Data from IDFG, ODFW and WDFW.

[b] Survival estimate made from PIT-tag detections of marked hatchery fish releases as part of the NMFS/UW survival studies for 1999-2000.

[c] These hatcheries have no survival estimates from the NMFS/UW survival studies, so they were set to the survival estimate of Dworshak National Fish Hatchery.

Table 5. Estimates of listed threatened and endangered steelhead arriving at McNary Dam during outmigration year 2001 under past transportation and spill conditions.

Snake River ESU

Rearing type	Total Collection* Granite	McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon**	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Wild	3,742,429	333,495	10.6	825,853	0.48	0.494	0.48	0.174	0.9	92,348	16,069	4.79

Upper Columbia River ESU

Rearing type	Number of listed fish passing dam Wells	Rocky Reach	Rock Island	Of dam total, % listed fish Wells	Rocky Reach	Rock Island	FGE[1] McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Wild***	158,301	220,571	224,300	20.3	25.3	23.3	0.174	0.9	163,515	28,452	8.48
Listed hatchery	520,318	561,462	658,889	66.8	64.4	68.3	0.174	0.9	538,172	93,642	27.90

Mid-Columbia River ESU

Rearing type	Total Collection* Granite	McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon**	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Summer-run	(First dam reached is McNary Dam)							0.174	0.9	69,433	12,081	3.60
Winter-run	(First dam reached is The Dalles Dam)											

*Note: Total Collection is the total number of fish collected of that species or run, regardless of rearing type.

**Note: Hatchery steelhead and listed wild steelhead enter the Snake River above Lower Monumental Dam. WDFW predicts that 25,000 wild fish and 195,000 hatchery fish will outmigrate from the Tucannon River in 2001 (Mark Schuck, WDFW, Pers. commun., February 2001).

***Note: Estimated values based on 2000 collection numbers (Fish Passage Center Weekly Reports), and on the number of adult returns from 1995-2000 (FPC Weekly Reports 1995-2000).

1 The FGE used in this table is adjusted for spill conditions, and PIT-tag detection efficiency at a dam. This estimate was obtained from the NMFS survival studies conducted in 1995-2000 (Steven G. Smith, NMFS, Pers. commun., January 2001).

Formulas:

a) Listed fish to Granite = $((\text{Collection}_{\text{Granite}})/(\text{FGE}_{\text{Granite}}))x(\text{Of Granite Total \% Listed Fish})$

b) Listed Fish to McNary = $(\text{Listed Fish to Granite})x(1-\text{FGE}_{\text{Granite}})x(\text{Project Survival})x(1-\text{FGE}_{\text{Goose}})x(\text{Project Survival})x(1-\text{FGE}_{\text{Low Mon}})x(\text{Project Survival})^2$ + $(\text{listed Tucannon fish})x(1-\text{FGE}_{\text{Low Mon}})x(\text{Project Survival})^2$ +(Rock Island listed fish)x(Project Survival)^2 +(PIT-tagged fish)

where: listed Tucannon fish = 25,000 wild
PIT-tagged fish = fish collected at Snake River dams, returned to the river, and subsequently arrived at McNary Dam; See Appendix Table B1.

Table 6. Estimates of listed threatened and endangered steelhead arriving at McNary Dam during outmigration year 2001 under full transportation conditions (no spill).

Snake River ESU

Rearing type	Total Collection* Granite	McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon**	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Wild	6,237,382	1,118,542	10.6	825,853	0.80	0.90	0.65	0.90	0.9	20,993	18,894	1.69

Upper Columbia River ESU

Rearing type	Number of listed fish passing dam Wells	Rocky Reach	Rock Island	Of dam total, % listed fish Wells	Rocky Reach	Rock Island	FGE[1] McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Wild***	158,301	220,571	224,300	20.3	25.3	23.3	0.90	0.9	163,515	147,164	13.16
Listed hatchery	520,318	561,462	658,889	66.8	64.4	68.3	0.90	0.9	538,172	484,355	43.30

Mid-Columbia River ESU

Rearing type	Total Collection* Granite	McNary	Of Granite Total % Listed Fish	Listed Fish to Granite[a]	FGE[1] Granite	Goose	Low Mon**	McNary	Project Survival	Listed fish to McNary[b]	Of Fish Collected at McNary Listed Fish	% Listed Fish
Summer-run	(First dam reached is McNary Dam)							0.90	0.9	69,433	62,490	5.59
Winter-run	(First dam reached is The Dalles Dam)											

*Note: Total Collection is the total number of fish collected of that species or run, regardless of rearing type.

**Note: Hatchery steelhead and listed wild steelhead enter the Snake River above Lower Monumental Dam. WDFW predicts that 25,000 wild fish and 195,000 hatchery fish will outmigrate from the Tucannon River in 2001 (Mark Schuck, WDFW, Pers. commun., February 2001).

***Note: Estimated values based on 2000 collection numbers (Fish Passage Center Weekly Reports), and on the number of adult returns from 1995-2000 (FPC Weekly Reports 1995-2000).

1 The FGE used in this table is adjusted for spill conditions, and PIT-tag detection efficiency at a dam. This estimate was obtained from the NMFS survival studies conducted in 1995-2000 (Steven G. Smith, NMFS, Pers. commun., January 2001).

Formulas:

a) Listed fish to Granite = $((\text{Collection}_{\text{Granite}})/(\text{FGE}_{\text{Granite}}))$x(Of Granite Total % Listed Fish)

b) Listed Fish to McNary = (Listed Fish to Granite)x$(1-\text{FGE}_{\text{Granite}})$x(Project Survival)x$(1-\text{FGE}_{\text{Goose}})$x(Project Survival)x$(1-\text{FGE}_{\text{Low Mon}})x(\text{Project Survival})^2$ + (listed Tucannon fish)x$(1-\text{FGE}_{\text{Low Mon}})x(\text{Project Survival})^2$ +(Rock Island listed fish)x$(\text{Project Survival})^2$ +(PIT-tagged fish)

where: listed Tucannon fish = 25,000 wild
PIT-tagged fish = fish collected at Snake River dams, returned to the river, and subsequently arrived at McNary Dam; See Appendix Table B1.

Appendix A.

Determination of the effects of returning all PIT-tagged spring/summer chinook salmon to the river at each collection dam on the number of fish that arrive at each subsequent dam

We surveyed researchers regarding the number of PIT-tagged fish we could expect moving downriver during the 2001 outmigration of spring/summer chinook salmon. We found that 208,000 hatchery fish will be PIT tagged and released above Lower Granite Dam as part of the Comparative Survival Study (CSS). We applied the hatchery survival estimates found in Table 1 to the fish released from hatcheries to determine the number of CSS hatchery fish that will arrive at Lower Granite Dam (133,986). The CSS requires that 75% of the fish collected at each of the Snake River collector dams be transported.

Another 27,787 hatchery spring/summer chinook salmon will be PIT tagged and released above Lower Granite Dam. Of the 161,773 (133,986 + 27,787) hatchery fish reaching Lower Granite Dam, 32,164 will be listed hatchery fish.

Because tagging for the 2001 outmigration year began in July 2000 and continues throughout the outmigration year, we cannot accurately estimate survival from tagging of natural and inriver fish to the head of the Lower Granite Reservoir. We assumed that all of these fish would survive to the head of the reservoir, realizing that this is an overestimation. We chose the head of the reservoir because that is where the last of the tagging occurs, and because we have survival estimates from the head of the reservoir to the tailrace of Lower Granite Dam. It is expected that 54,596 wild spring/summer chinook salmon will be PIT tagged above Lower Granite Dam. Using 90% survival from tagging location through the Lower Granite Dam pool, 49,136 (54,596 x 0.90) will arrive at Lower Granite Dam.

The National Marine Fisheries Service will be PIT-tagging fish at Lower Granite Dam during the 2001 outmigration. As part of this marking, 5,000 PIT-tagged wild fish will be released into the Lower Granite Dam tailrace.

Approximately 800 fish (400 wild and 400 hatchery) will be released in the Tucannon River. These fish are assumed to arrive at Lower Monumental Dam with no mortality.

We performed two calculations to determine the expected number of PIT-tagged fish collected at each collector dam. The first calculation made use of the same formulas used under the "Transportation with Spill" and "Full Transportation" scenarios which assume that every fish collected is transported (except the CSS fish). This calculation provided the number of fish collected at each dam if no PIT-tagged fish were returned to the river. In other words, this calculation is based solely on the number of fish that are not collected and transported at upstream dam(s).

In the second calculation we assumed that the only fish transported at each Snake River collector dam are the CSS fish. This calculation provided the number of fish collected at each dam if the remaining PIT-tagged fish were returned to the river. This calculation includes both the fish that were returned to the river at upstream dam(s) and the fish that were not collected at upstream dam(s). Because the number derived from the second calculation includes the number from the first calculation, the difference between the numbers from these two calculations is the number of PIT-tagged fish that were collected at each dam that were not accounted for because they were returned to the river at each dam (the number for each dam was added to the appropriate "... fish collected ..." columns in Tables 7-8). This difference in the number of fish collected was then expanded to the number of fish that arrived at the dam by dividing by the FGE of that dam, and was added to the number of fish that arrived at McNary Dam because they had not been collected and transported at upstream dams under both the “Transportation with Spill” and “Full Transportation” scenarios (column "Listed fish to McNary" in Tables 2 and 3, respectively).

Calculation 1 (Transportation)

Transportation with Spill Scenario--The numbers presented below assume that 57.4% of the PIT-tagged fish arriving at Lower Granite Dam will not be collected (FGE = 42.6%), and that 25% of the CSS fish are returned to the river. In addition, 5,000 wild fish will be released into the tailrace of Lower Granite Dam from marking at the dam.

Using the FGEs in Table 2, the estimated number of PIT-tagged fish collected at each dam below Lower Granite Dam in 2001 will be

Dam	Wild	Listed hatchery	Unlisted hatchery	Total
Little Goose	14,488	7,361	25,956	47,805
Lower Monumental	6,466	3,361	11,308	21,135
McNary	3,070	1,596	5,370	10,036

Full Transportation Scenario--The numbers presented below assume that 40% of the PIT-tagged fish arriving at Lower Granite Dam will not be collected (FGE = 60%), and that 25% of the CSS fish are returned to the river. In addition, 5,000 wild fish will be released into the tailrace of Lower Granite Dam from marking at the dam.

Using the FGEs in Table 3, the estimated number of PIT-tagged fish collected at each dam below Lower Granite Dam in 2001 will be

Dam	Wild	Listed hatchery	Unlisted hatchery	Total
Little Goose	15,700	7,526	26,539	49,765
Lower Monumental	4,004	2,024	6,431	12,459
McNary	2,595	1,311	4,167	8,073

Calculation 2 (Only CSS fish transported)

This calculation assumes that all collected PIT-tagged fish (except the CSS fish) are returned to the river at each Snake River collector dam.

For the PIT-tagged fish returned to the river at each collection dam, the only loss of fish as they migrate downstream is the mortality through each reservoir and dam. Based on the NMFS survival studies, survival through each reservoir and dam was estimated to be 90%. The estimated number of PIT-tagged fish collected at each dam below Lower Granite Dam in 2001 will be

Transportation with Spill Scenario

Dam	Wild	Listed hatchery	Unlisted hatchery	Total
Little Goose	23,761	9,214	31,761	64,736
Lower Monumental	18,739	5,363	17,393	41,495
McNary	14,469	3,246	10,092	27,807

Full Transportation Scenario

Dam	Wild	Listed hatchery	Unlisted hatchery	Total
Little Goose	34,864	11,356	38,536	84,756
Lower Monumental	24,337	4,984	15,207	44,528
McNary	31,541	4,888	13,847	50,274

Subtracting collection numbers estimated by Calculation 1 from Calculation 2 provides the number of unaccounted for PIT-tagged fish that were collected at each dam (Appendix Table A1).

Appendix Table A1. Estimates of the number of unaccounted for PIT-tagged fish that will be collected at each of the collection dams, and estimates of how many of these fish will arrive at McNary Dam, 2001.

Transportation with Spill Scenario

Dam	Wild	Listed hatchery	Unlisted hatchery	Total
Number of unaccounted for PIT-tagged fish collected:				
Little Goose	9,273	1,853	5,805	16,931
Lower Monumental	12,273	2,002	6,085	20,360
McNary	11,398	1,650	4,722	17,770
Number of unaccounted for PIT-tagged fish that arrived at McNary Dam (FGE = 0.367):				
McNary	31,058	4,495	12,867	48,420

Full Transportation Scenario

Dam	Wild	Listed hatchery	Unlisted hatchery	Total
Number of unaccounted for PIT-tagged fish collected:				
Little Goose	19,164	3,830	11,997	34,991
Lower Monumental	20,333	2,960	8,776	32,069
McNary	28,946	3,576	9,680	42,202
Number of unaccounted for PIT-tagged fish that arrived at McNary Dam (FGE = 0.80):				
McNary	36,182	4,470	12,100	52,752

Appendix B.

Determination of the effects of returning all PIT-tagged steelhead to the river at each collection dam on the number of fish that arrive at each subsequent dam

We surveyed researchers regarding the number of PIT-tagged fish we could expect moving downriver during the 2001 outmigration of steelhead in the Snake River. We found that 1,500 Dworshak National Fish Hatchery fish will be PIT tagged and released above Lower Granite Dam as part of a transportation evaluation. The survival rate of these fish is 77.2%, therefore, we estimate that 1,158 will arrive at Lower Granite Dam. Another 14,150 hatchery steelhead will be PIT tagged at traps and released above Lower Granite Dam, bringing the total to 15,308 hatchery fish arriving at Lower Granite Dam. In addition, 5,400 wild steelhead will be PIT tagged at traps and released above Lower Granite Dam.

The National Marine Fisheries Service will be PIT-tagging steelhead at Lower Granite Dam during the 2001 outmigration. As part of this marking, 35,000 PIT-tagged fish will be released into the Lower Granite Dam tailrace. Of these, approximately 10,000 will be wild fish and 25,000 will be hatchery fish.

We performed two calculations to determine the expected number of PIT-tagged fish collected at each collector dam. The first calculation made use of the same formulas used under the "Transportation with Spill" and "Full Transportation" scenarios which assume that every fish collected is transported. This calculation provided the number of fish collected at each dam if no PIT-tagged fish were returned to the river. In other words, this calculation is based solely on the number of fish that are not collected and transported at upstream dam(s).

In the second calculation we assumed that no fish are transported. This calculation provided the number of fish collected at each dam if all PIT-tagged fish were returned to the river. This calculation includes both the fish that were returned to the river at upstream dam(s) and the fish that were not collected at upstream dam(s). Because the number derived from the second calculation includes the number from the first calculation, the difference between the numbers from these two calculations is the number of PIT-tagged fish that were collected at each dam that were not accounted for because they were returned to the river at each dam (the number for each dam was added to the appropriate "... fish collected ..." columns in Tables 9-10). This difference in the number of fish collected was then expanded to the number of fish that arrived at the dam by dividing by the FGE of that dam, and was added to the number of fish that arrived at McNary Dam because they had not been collected and transported at upstream dams under both the “Transportation with Spill” and “Full Transportation” scenarios (column "Listed fish to McNary" in Tables 5 and 6, respectively).

Calculation 1 (Transportation)
Transportation with Spill Scenario--Assuming that 52.0% of the PIT-tagged fish arriving at Lower Granite Dam will not be

collected (FGE = 48.0%), 2,808 (5,400 x 0.52) wild and 7,960 (15,308 x 0.52) unlisted hatchery fish will reach the Lower Granite Dam tailrace. In addition, 10,000 wild and 25,000 unlisted hatchery fish will be released into the tailrace from marking at the dam. Therefore, the total numbers of PIT-tagged fish in the Lower Granite Dam tailrace will be 12,808 (2,808 + 10,000) wild and 32,960 (7,960 + 25,000) unlisted hatchery fish.

Using the FGEs in Table 5, the estimated number of PIT-tagged fish collected at each dam below Lower Granite Dam in 2001 will be

Dam	Wild	Unlisted hatchery	Total
Little Goose	5,694	14,654	20,348
Lower Monumental	2,760	6,820	9,580
McNary	421	1,102	1,523

Full Transportation Scenario--Assuming that 20% of the PIT-tagged fish arriving at Lower Granite Dam will not be collected (FGE = 80%), 1,080 (5,400 x 0.20) wild and 3,062 (15,308 x 0.20) unlisted hatchery fish will reach the Lower Granite Dam tailrace. In addition, 10,000 wild and 25,000 unlisted hatchery fish will be released into the tailrace from marking at the dam. Therefore, the total numbers of PIT-tagged fish in the Lower Granite Dam tailrace will be 11,080 (1,080 + 10,000) wild and 28,062 (3,062 + 25,000) unlisted hatchery fish.

Using the FGEs in Table 6, the estimated number of PIT-tagged fish collected at each dam below Lower Granite Dam in 2001 will be

Dam	Wild	Unlisted hatchery	Total
Little Goose	8,975	22,730	31,705
Lower Monumental	908	1,932	2,840
McNary	357	1,074	1,431

Calculation 2 (No Transportation)

Assuming that 100% of the collected PIT-tagged fish are returned to the river at Lower Granite Dam, 15,400 (5,400 + 10,000) wild and 40,308 (15,308 + 25,000) unlisted hatchery fish will reach the tailrace.

Because 100% of the PIT-tagged fish were assumed to be returned to the river at each collection dam, the only loss of fish as they migrate downstream is the mortality through each reservoir and dam. Based on the NMFS survival studies, survival through

each reservoir and dam was estimated to be 90%. The estimated number of PIT-tagged fish collected at each dam below Lower Granite Dam in 2001 will be

Transportation with Spill Scenario

Dam	Wild	Unlisted hatchery	Total
Little Goose	6,847	17,921	24,768
Lower Monumental	5,988	15,672	21,660
McNary	1,758	4,602	6,360

Full Transportation Scenario

Dam	Wild	Unlisted hatchery	Total
Little Goose	12,474	32,649	45,123
Lower Monumental	8,433	21,677	30,110
McNary	9,458	24,627	34,085

Subtracting collection numbers estimated by Calculation 1 from Calculation 2 provides the number of unaccounted for PIT-tagged fish that were collected at each dam (Appendix Table B1).

Appendix Table B1. Estimates of the number of unaccounted for PIT-tagged fish that will be collected at each of the collection dams, and estimates of how many of these fish will arrive at McNary Dam, 2001.

Transportation with Spill Scenario

Dam	Wild	Unlisted hatchery	Total
Number of unaccounted for PIT-tagged fish collected:			
Little Goose	1,152	3,267	4,419
Lower Monumental	3,228	8,851	12,079
McNary	1,337	3,499	4,836
Number of unaccounted for PIT-tagged fish that arrived at McNary Dam (FGE = 0.174):			
McNary	7,682	20,111	27,793

Full Transportation Scenario

Dam	Wild	Unlisted hatchery	Total
Number of unaccounted for PIT-tagged fish collected:			
Little Goose	3,499	9,920	13,419
Lower Monumental	7,525	19,745	27,270
McNary	9,101	23,553	32,654
Number of unaccounted for PIT-tagged fish that arrived at McNary Dam (FGE = 0.90):			
McNary	10,113	26,170	36,283

Table 7. Juvenile collection at each of eight mainstem collection facilities in 2001 under full transportation and transportation with spill scenarios.

	Full Transportation Scenario				Transportation with Spill Scenario			
	Chinook salmon				Chinook salmon			
	Spring/Summer		Fall	Sockeye	Spring/Summer		Fall	Sockeye
	Wild	Hatchery	Subyearling	salmon	Wild	Hatchery	Subyearling	salmon
Total fish collected at:*								
Lower Granite	1,740,616	1,740,616	836,950	10,218	1,235,837	1,235,837	820,211	5,279
Little Goose	713,830	713,830	308,150	3,985	680,842	680,842	252,546	3,056
Lower Monumental	254,557	254,557	144,830	966	354,264	354,264	183,045	2,172
Ice Harbor**	155,311	155,311	73,320	521	320,305	320,305	77,675	2,481
Columbia River								
Wells***	333,027	333,027	NA	NA	333,027	333,027	NA	NA
Rocky Reach***	628,662	628,662	NA	NA	628,662	628,662	NA	NA
Rock Island***	1,933,298	1,933,298	NA	NA	1,933,298	1,933,298	NA	NA
Wanapum***	1,739,968	1,739,968	NA	NA	1,739,968	1,739,968	NA	NA
Priest Rapids***	1,565,971	1,565,971	NA	NA	1,565,971	1,565,971	NA	NA
McNary****	2,446,509	2,446,509	7,632,121	583,008	1,213,078	1,213,078	5,583,066	583,008
John Day** ****	704,454	704,454	2,592,319	1,129,324	350,939	350,939	1,718,128	229,629
The Dalles** ****	780,292	780,292	1,388,742	677,594	1,260,034	1,260,034	1,070,263	677,594
Bonneville (I & II combined)** *****	2,320,466	2,320,466	5,943,481	609,835	1,341,714	1,341,714	4,582,048	271,377
---To the tailrace of Bonneville	5,801,165	5,801,165	19,811,603	1,524,587	6,880,585	6,880,585	18,856,164	1,524,587
---To Tongue Point*****	23,704,323	23,704,323	38,571,680	2,122,764	23,166,452	23,166,452	35,533,058	2,118,103
Total listed fish at:								
Lower Granite	286,920	308,218	515,695	9,185	203,913	218,829	505,381	4,746
Little Goose	131,062	124,035	189,869	3,582	118,818	119,411	155,609	2,747
Lower Monumental	55,447	82,087	41,174	868	66,158	91,718	59,553	1,953
Ice Harbor**	43,083	45,709	20,844	469	67,187	80,386	25,272	2,231
Columbia River								
Wells***	25,650	276,407	NA	NA	25,650	276,407	NA	NA
Rocky Reach***	42,323	248,766	NA	NA	42,323	248,766	NA	NA
Rock Island***	76,565	290,889	NA	NA	76,565	290,889	NA	NA
Wanapum***	68,909	261,800	NA	NA	68,909	261,800	NA	NA
Priest Rapids***	62,018	235,620	NA	NA	62,018	235,620	NA	NA
McNary****	96,353	224,497	22,581	562	57,471	122,078	20,007	729
John Day** ****	13,008	30,307	3,192	76	12,490	26,530	4,992	287
The Dalles** ****	7,805	18,184	1,710	46	32,117	68,221	3,110	848
Bonneville (I & II combined)** *****	147,898	16,366	705,152	41	82,767	29,932	572,193	340
---To the tailrace of Bonneville	369,746	40,915	2,350,506	103	424,448	153,498	2,354,705	1,907
---To Tongue Point*****	4,453,192	769,385	12,957,851	14,300	4,419,971	700,029	8,643,042	12,083
Percent listed fish at:								
Lower Granite	16.48%	17.71%	61.62%	89.89%	16.50%	17.71%	61.62%	89.89%
Little Goose	18.36%	17.38%	61.62%	89.89%	17.45%	17.54%	61.62%	89.89%
Lower Monumental	21.78%	32.25%	28.43%	89.89%	18.67%	25.89%	32.53%	89.89%
Ice Harbor**	27.74%	29.43%	28.43%	89.89%	20.98%	25.10%	32.53%	89.89%
Columbia River								
Wells***	7.70%	83.00%	NA	NA	7.70%	83.00%	NA	NA
Rocky Reach***	6.73%	39.57%	NA	NA	6.73%	39.57%	NA	NA
Rock Island***	3.96%	15.05%	NA	NA	3.96%	15.05%	NA	NA
Wanapum***	3.96%	15.05%	NA	NA	3.96%	15.05%	NA	NA
Priest Rapids***	3.96%	15.05%	NA	NA	3.96%	15.05%	NA	NA
McNary****	3.94%	9.18%	0.30%	0.10%	4.74%	10.06%	0.36%	0.13%
John Day** ****	1.85%	4.30%	0.12%	0.01%	3.56%	7.56%	0.29%	0.13%
The Dalles** ****	1.00%	2.33%	0.12%	0.01%	2.55%	5.41%	0.29%	0.13%
Bonneville (I & II combined)** *****	6.37%	0.71%	11.86%	0.01%	6.17%	2.23%	12.49%	0.13%
---To the tailrace of Bonneville	6.37%	0.71%	11.86%	0.01%	6.17%	2.23%	12.49%	0.13%
---To Tongue Point*****	18.79%	3.25%	33.59%	0.67%	19.08%	3.02%	24.32%	0.57%

* Note: "Total fish collected at:" is the total number of fish collected of that species or run, regardless of rearing type.
** Note: These dams have no transportation facilities, therefore, no fish are removed from the river at these dams.
*** Note: The numbers shown for these dams represent the number of fish arriving at the dam, not the number collected; FGE's at these dams are not established at this time. Also, there is no transportation from these dams
**** Note: (See next page)
***** Note: (See next page)

Table 8. Juvenile spring/summer chinook salmon collection at each of the mainstem collection facilities in 2001 under full transportation and transportation with spill scenarios. Percentage of listed fish by rearing type (wild or hatchery) at each facility.

	Full Transportation Scenario		**Transportation with Spill Scenario**	
	Spring/Summer chinook salmon		Spring/Summer chinook salmon	
	Wild	Listed hatchery	Wild	Listed hatchery
Total fish collected at:*				
Lower Granite	286,920	1,453,696	203,713	1,032,124
Little Goose	131,062	582,768	118,711	562,132
Lower Monumental	55,447	199,111	66,112	288,153
Ice Harbor**	43,083	112,229	67,146	253,159
Columbia River				
Wells***	25,650	307,377	25,650	307,377
Rocky Reach***	42,323	586,339	42,323	586,339
Rock Island***	76,565	1,856,733	76,565	1,856,733
Wanapum***	68,909	1,671,060	68,909	1,671,060
Priest Rapids***	62,018	1,503,954	62,018	1,503,954
McNary****	330,053	2,116,456	164,658	1,048,420
John Day** ****	202,732	501,722	72,692	278,247
The Dalles** ****	159,259	621,033	224,542	1,035,493
Bonneville (I & II combined)** *****	284,208	2,036,258	167,194	1,174,520
---To the tailrace of Bonneville	710,519	5,090,646	857,405	6,023,180
---To Tongue Point*****	5,030,225	18,674,099	4,962,321	18,204,131
Total listed fish at:				
Lower Granite	286,920	308,218	203,913	218,829
Little Goose	131,062	124,035	118,818	119,411
Lower Monumental	55,447	82,087	66,158	91,718
Ice Harbor**	43,083	45,709	67,187	80,386
Columbia River				
Wells***	25,650	276,407	25,650	276,407
Rocky Reach***	42,323	248,766	42,323	248,766
Rock Island***	76,565	290,889	76,565	290,889
Wanapum***	68,909	261,800	68,909	261,800
Priest Rapids***	62,018	235,620	62,018	235,620
McNary****	96,353	224,497	57,471	122,078
John Day** ****	13,008	30,307	12,490	26,530
The Dalles** ****	7,805	18,184	32,117	68,221
Bonneville (I & II combined)** *****	147,898	16,366	82,767	29,932
---To the tailrace of Bonneville	369,746	40,915	424,448	153,498
---To Tongue Point*****	4,453,192	769,385	4,419,971	700,029
Percent listed fish at:				
Lower Granite	100.00%	21.20%	100.10%	21.20%
Little Goose	100.00%	21.28%	100.09%	21.24%
Lower Monumental	100.00%	41.23%	100.07%	31.83%
Ice Harbor**	100.00%	40.73%	100.06%	31.75%
Columbia River				
Wells***	100.00%	89.92%	100.00%	89.92%
Rocky Reach***	100.00%	42.43%	100.00%	42.43%
Rock Island***	100.00%	15.67%	100.00%	15.67%
Wanapum***	100.00%	15.67%	100.00%	15.67%
Priest Rapids***	100.00%	15.67%	100.00%	15.67%
McNary****	29.19%	10.61%	34.90%	11.64%
John Day** ****	6.42%	6.04%	17.18%	9.53%
The Dalles** ****	4.90%	2.93%	14.30%	6.59%
Bonneville (I & II combined)** *****	52.04%	0.80%	49.50%	2.55%
---To the tailrace of Bonneville	52.04%	0.80%	49.50%	2.55%
---To Tongue Point*****	88.53%	4.12%	89.07%	3.85%

* Note: "Total fish collected at:" is the total number of fish collected of that species or run, regardless of rearing type.

** Note: These dams have no transportation facilities, therefore, no fish are removed from the river at these dams.

*** Note: The numbers shown for these dams represent the number of fish arriving at the dam, not the number collected; FGE's at these dams are not established at this time. Also, there is no transportation from these dams

**** Note: (See next page)

***** Note: (See next page)

**** Note: The percentage of listed wild and hatchery spring/summer and fall chinook salmon at McNary, John Day, and The Dalles Dams are:
For example, If you handle 1,000 yearling chinook salmon at Tongue Point, under the Full Transportation with spill scenario (Table 7), 19.08% of them will be listed wild fish, or 191 fish. To these 191 fish, you would apply the percentages listed below under the Tongue Point section to determine how many are from each ESU (SR, 191 x 0.1003 = 19; UCR, 191 x 0.0095 = 2; etc).

Spring/Summer	**Full Transportation**		**Full Transportation with spill**	
chinook salmon	**Wild**	**Hatchery**	**Wild**	**Hatchery**
SR	53.66	24.40	64.34	36.20
UCR	46.34	75.60	35.66	63.80
LCR - Springs	---	---	---	---
UWR	---	---	---	---
Fall				
chinook salmon				
SR	100.00	---	100.00	---
LCR - Tule falls	---	---	---	---
LCR - Late run falls	---	---	---	---

***** Note: Because the Columbia River is a free flowing river below Bonneville Dam and there are no survival estimates available, survival was set at 100% to Tongue Point.
The percentage of listed wild and hatchery spring/summer and fall chinook salmon at and downstream of Bonneville Dam are:

Bonneville Dam

Spring/Summer	**Full Transportation**		**Full Transportation with spill**	
chinook salmon	**Wild**	**Hatchery**	**Wild**	**Hatchery**
SR	2.55	24.40	10.95	36.20
UCR	2.20	75.60	6.07	63.80
LCR - Springs	95.25	---	82.98	---
UWR	---	---	---	---
Fall				
chinook salmon				
SR	0.22	---	0.40	---
LCR - Tule falls	99.78	---	99.60	---
LCR - Late run falls	---	---	---	---

Tongue Point

Spring/Summer	**Full Transportation**		**Full Transportation with spill**	
chinook salmon	**Wild**	**Hatchery**	**Wild**	**Hatchery**
SR	10.77	74.30	10.03	75.10
UCR	0.88	25.70	0.95	24.90
LCR - Springs	75.67	---	76.24	---
UWR	12.67	---	12.77	---
Fall				
chinook salmon				
SR	5.98	---	5.80	---
LCR - Tule falls	60.91	---	61.03	---
LCR - Late run falls	33.11	---	33.17	---

SR = Snake River ESU
UCR = Upper Columbia River ESU
LCR - Springs = Lower Columbia River ESU - Spring chinook
UWR = Upper Willamette River ESU

LCR - Tule falls = Lower Columbia River ESU - Tule fall chinook salmon
LCR - Late run falls = Lower Columbia River ESU - Late-run bright fall chinook salmon

Table 9. Juvenile steelhead trout collection at each of the mainstem collection facilities in 2001 under full transportation, no transportation, and transportation with spill scenarios.

	Full Transportation Scenario			Transportation with Spill Scenario		
	Wild steelhead trout	Listed hatchery steelhead trout	Wild chum salmon	Wild steelhead trout	Listed hatchery steelhead trout	Wild chum salmon
Total fish collected at:*						
Snake River						
Lower Granite	6,237,382	6,237,382	0	3,742,429	3,742,429	0
Little Goose	1,276,489	1,276,489	0	1,806,960	1,806,960	0
Lower Monumental	252,369	252,369	0	915,293	915,293	0
Ice Harbor**	112,051	112,051	0	683,928	683,928	0
Columbia River						
Wells***	778,379	778,379	0	778,379	778,379	0
Rocky Reach***	871,817	871,817	0	871,817	871,817	0
Rock Island***	963,995	963,995	0	963,995	963,995	0
Wanapum***	867,596	867,596	0	867,596	867,596	0
Priest Rapids***	780,836	780,836	0	780,836	780,836	0
McNary****	1,118,542	1,118,542	0	335,598	335,598	0
John Day** ****	342,978	342,978	0	476,537	476,537	0
The Dalles** ****	354,844	354,844	0	949,727	949,727	0
Bonneville (I & II combined)** *****	469,249	469,249	0	446,361	446,361	0
---To the tailrace of Bonneville	853,180	853,180	0	1,923,968	1,923,968	0
---To Tongue Point****	14,923,748	14,923,748	301,320	13,962,044	13,962,044	301,320
Total listed fish at:						
Snake River						
Lower Granite	660,682	0	0	396,409	0	0
Little Goose	137,287	0	0	192,083	0	0
Lower Monumental	32,471	0	0	99,713	0	0
Ice Harbor**	17,494	0	0	76,957	0	0
Columbia River						
Wells***	158,301	520,318	0	158,301	520,318	0
Rocky Reach***	220,571	561,462	0	220,571	561,462	0
Rock Island***	224,300	658,889	0	224,300	658,889	0
Wanapum***	201,870	593,000	0	201,870	593,000	0
Priest Rapids***	181,683	533,700	0	181,683	533,700	0
McNary****	228,547	484,355	0	56,602	93,642	0
John Day** ****	175,678	33,905	0	123,594	105,220	0
The Dalles** ****	153,794	21,796	0	252,331	180,035	0
Bonneville (I & II combined)** *****	170,956	21,578	0	113,262	75,182	0
---To the tailrace of Bonneville	310,830	39,233	0	488,198	324,062	0
---To Tongue Point****	1,726,689	523,588	301,320	1,604,286	417,704	301,320
Percent listed fish at:						
Snake River						
Lower Granite	10.59%	0.00%	----	10.59%	0.00%	----
Little Goose	10.76%	0.00%	----	10.63%	0.00%	----
Lower Monumental	12.87%	0.00%	----	10.89%	0.00%	----
Ice Harbor**	15.61%	0.00%	----	11.25%	0.00%	----
Columbia River						
Wells***	20.34%	66.85%	----	20.34%	66.85%	----
Rocky Reach***	25.30%	64.40%	----	25.30%	64.40%	----
Rock Island***	23.27%	68.35%	----	23.27%	68.35%	----
Wanapum***	23.27%	68.35%	----	23.27%	68.35%	----
Priest Rapids***	23.27%	68.35%	----	23.27%	68.35%	----
McNary****	20.43%	43.30%	----	16.87%	27.90%	----
John Day** ****	51.22%	9.89%	----	25.94%	22.08%	----
The Dalles** ****	43.34%	6.14%	----	26.57%	18.96%	----
Bonneville (I & II combined)** *****	36.43%	4.60%	----	25.37%	16.84%	----
---To the tailrace of Bonneville	36.43%	4.60%	----	25.37%	16.84%	----
---To Tongue Point****	11.57%	3.51%	100.00%	11.49%	2.99%	100.00%

* Note: "Total fish collected at:" is the total number of fish collected of that species or run, regardless of rearing type.

** Note: These dams have no transportation facilities, therefore, no fish are removed from the river at these dams.

*** Note: The numbers shown for these dams represent the number of fish arriving at the dam, not the number collected; FGE's at these dams are not established at this time. Also, there is no transportation from these dams

**** Note: (See next page)

Table 10. Juvenile steelhead trout collection at each of the mainstem collection facilities in 2001 under full transportation, no transportation, and transportation with spill scenarios. Percentage of listed fish by rearing type (wild or hatchery) at each facility.

	Full Transportation Scenario		Transportation with Spill Scenario	
	Wild steelhead trout	Listed hatchery steelhead trout	Wild steelhead trout	Listed hatchery steelhead trout
Total fish collected at:*				
Snake River				
Lower Granite	660,682	5,576,699	396,409	3,346,020
Little Goose	137,287	1,139,201	192,083	1,614,877
Lower Monumental	32,471	219,898	99,713	815,579
Ice Harbor**	17,494	94,557	76,957	606,971
Columbia River				
Wells***	158,301	520,318	158,301	520,318
Rocky Reach***	220,571	651,246	220,571	651,246
Rock Island***	224,300	739,695	224,300	739,695
Wanapum***	201,870	665,726	201,870	665,726
Priest Rapids***	181,683	599,153	181,683	599,153
McNary****	228,547	889,995	56,602	278,997
John Day** ****	175,678	167,300	123,594	352,943
The Dalles** ****	153,794	201,050	252,331	697,395
Bonneville (I & II combined)** ****	170,956	298,292	113,261	333,099
---To the tailrace of Bonneville	310,830	542,350	488,196	1,435,772
---To Tongue Point******	2,114,873	12,823,328	1,992,467	11,971,741
Total listed fish at:				
Snake River				
Lower Granite	660,682	0	396,409	0
Little Goose	137,287	0	192,083	0
Lower Monumental	32,471	0	99,713	0
Ice Harbor**	17,494	0	76,957	0
Columbia River				
Wells***	158,301	520,318	158,301	520,318
Rocky Reach***	220,571	561,462	220,571	561,462
Rock Island***	224,300	658,889	224,300	658,889
Wanapum***	201,870	593,000	201,870	593,000
Priest Rapids***	181,683	533,700	181,683	533,700
McNary****	228,547	484,355	56,602	93,642
John Day** ****	175,678	33,905	123,594	105,220
The Dalles** ****	153,794	21,796	252,331	180,035
Bonneville (I & II combined)** ****	170,956	21,578	113,262	75,182
---To the tailrace of Bonneville	310,830	39,233	488,198	324,062
---To Tongue Point******	1,726,689	523,588	1,604,286	417,704
Percent listed fish at:				
Snake River				
Lower Granite	100.00%	0.00%	100.00%	0.00%
Little Goose	100.00%	0.00%	100.00%	0.00%
Lower Monumental	100.00%	0.00%	100.00%	0.00%
Ice Harbor**	100.00%	0.00%	100.00%	0.00%
Columbia River				
Wells***	100.00%	100.00%	100.00%	100.00%
Rocky Reach***	100.00%	86.21%	100.00%	86.21%
Rock Island***	100.00%	89.08%	100.00%	89.08%
Wanapum***	100.00%	89.08%	100.00%	89.08%
Priest Rapids***	100.00%	89.08%	100.00%	89.08%
McNary****	100.00%	54.42%	100.00%	33.56%
John Day** ****	100.00%	20.27%	100.00%	29.81%
The Dalles** ****	100.00%	10.84%	100.00%	25.82%
Bonneville (I & II combined)** ****	100.00%	7.23%	100.00%	22.57%
---To the tailrace of Bonneville	100.00%	7.23%	100.00%	22.57%
---To Tongue Point****	81.65%	4.08%	80.52%	3.49%

* Note: "Total fish collected at:" is the total number of fish collected of that species, run and rearing type.

** Note: These dams have no transportation facilities, therefore, no fish are removed from the river at these dams.

*** Note: The numbers shown for these dams represent the number of fish arriving at the dam, not the number collected; FGE's at these dams are not established at this time. Also, there is no transportation from these dams

**** Note: (See next page)

**** Note: The percentage of listed wild fish from each ESU at each Columbia River dam from McNary Dam to Bonneville Dam and at Tongue Point. All listed hatchery fish are from the Upper Columbia River ESU.

For example, If you handle 1,000 steelhead at Tongue Point, under the Full Transportation with spill scenario (Table 9), 11.49% of them will be listed wild fish, or 115 fish. To these 115 fish, you would apply the percentages listed below under the Tongue Point section to determine how many are from each ESU (SR, 115 x 0.4779 = 55; UCR, 115 x 0.0799 = 9; etc).

McNary Dam	**Full Transportation**	**Full Transportation with spill**
SR	8.27	28.39
UCR	64.39	50.27
MCR - Summers	27.34	21.34
MCR - Winters	---	---
LCR	---	---
UWR	---	---
John Day Dam		
SR	0.83	15.35
UCR	6.45	27.19
MCR - Summers	92.72	57.46
MCR - Winters	---	---
LCR	---	---
UWR	---	---
The Dalles Dam		
SR	0.61	12.94
UCR	4.72	22.91
MCR - Summers	88.77	60.69
MCR - Winters	5.90	3.47
LCR	---	---
UWR	---	---
Bonneville Dam		
SR	0.53	11.99
UCR	4.16	21.23
MCR - Summers	78.24	56.24
MCR - Winters	5.20	3.21
LCR	11.87	7.33
UWR	---	---
Tongue Point		
SR	49.29	47.79
UCR	9.00	7.99
MCR - Summers	16.69	17.26
MCR - Winters	0.88	0.94
LCR	13.33	14.37
UWR	10.81	11.65

SR = Snake River ESU
UCR = Upper Columbia River ESU
MCR - Summers = Mid Columbia River ESU summer steelhead
MCR - Winters = Mid Columbia River ESU winter steelhead
LCR = Lower Columbia River ESU
UWR = Upper Willamette River ESU